

REMARKS

Claims 1-18 remain pending in this application. Claims 17-18 have been withdrawn from consideration as being directed to a non-elected species. Each of the examined claims is believed to define an invention which is novel and unobvious over the cited references. Favorable reconsideration of this case is respectfully requested.

Copies of Figures 3a-3f and 4 are submitted herewith on separate sheets with the corrections required by the Examiner indicated in red ink. Upon the approval of the Examiner, these changes will be made by a draftsman of the undersigned.

The present invention relates to a method of etching semiconductor devices using a hydrogen peroxide-water mixture. The hydrogen peroxide-water mixture is used to etch a titanium or a titanium nitride film. Using a hydrogen peroxide-water mixture for etching a titanium or titanium nitride film avoids an increase in sheet resistance and an increase in the fluctuation in the resistance of the CoSi_2 that is present. Please see the present specification, for example, page 5, lines 15-20, for this and other advantages of the present invention.

Claims 1, 4, 5 and 8 have been rejected under 35 U.S.C. § 103(a) as being obvious over Applicant's admitted prior art in view of Derderian et al., U.S. Patent 6,245,191.

Applicant's admitted prior art is directed to a method of producing semiconductor devices using cobalt salicide technology. As noted in Section 3 of the Office Action the

admitted prior art fails to teach etching using a hydrogen peroxide-water mixture. Derderian is cited as teaching this feature.

Derderian relates to methods of etching by use of maskless techniques. Derderian is not directed to the production of semiconductors and makes no disclosure or suggestion of a cobalt film formed under a titanium or titanium nitride film. There is no mention in Derderian that a hydrogen peroxide-water mixture may be used to etch a titanium or titanium nitride film arranged on a cobalt film without damaging the cobalt film. Such damage results in the sheet resistance of the cobalt film increasing, among other problems, see pg. 4, lines 12-20 of the present specification.

The claimed method overcomes the problem of damage to the cobalt film. For example, claims 1, 4, 5, and 8 require a titanium or titanium nitride film is formed as a cap film on top of a cobalt film. The titanium or titanium nitride film is then removed using a hydrogen peroxide-water mixture. Removing the titanium or titanium nitride film in this manner avoids an increase in sheet resistance and an increase in the fluctuation in the resistance of the cobalt film, see the present specification, page 5, lines 15-20. There is no teaching in the cited art of the advantages achieved by the present invention.

In view of the above discussion, it would not have been obvious to one of ordinary skill in the art to apply a "hydrogen-peroxide and water mixture" as mentioned in Derderian to Applicant's admitted prior art. "There must be some reason, suggestion, or motivation found in the prior art whereby a person of ordinary skill in the field of the invention would make the combination. That knowledge cannot come from the

applicant's invention itself." In re Oetiker, 977 F.2d 1443 (Fed. Cir. 1992). The use of hindsight to find obviousness is impermissible. "The combination of elements from non-analogous sources, in a manner that reconstructs the applicant's invention only with the benefit of hindsight, is insufficient to present a prima facie case of obviousness." *Id.* Accordingly, in the present case, there is no such motivation to combine the cited references without the impermissible use of hindsight. Accordingly, Applicant respectfully requests that the rejection of claims 1, 4, 5, and 8 be withdrawn.

Claims 2, 3, 6, 7, 10, 11, 14, and 15 have been rejected under 35 U.S.C. § 103(a) as being obvious over Applicant's admitted prior art in view of Derderian et al., U.S. Patent 6,245,191 as applied above.

Each of claims 2, 3, 6, 7, 10, 11, 14, and 15 depend directly or indirectly from independent claims 1, 4, 5, and 8 discussed above and are patentable over the cited references for at least the reasons discussed above regarding claims 1, 4, 5, and 8. Therefore, the withdrawal of this rejection is respectfully requested. ...

Claims 9, 12, 13, and 16 have been rejected under 35 U.S.C. § 103(a) as being obvious over Applicant's admitted prior art in view of Jang, U.S. Patent 6,051,496.

The cited references do not render the claimed invention obvious as they do not teach or suggest, among other things, using an ammonia-hydrogen peroxide-water mixture to remove a first portion of a titanium or titanium nitride film such that a second portion of the titanium or titanium nitride film remains covering the CoSi film.

For example, claims 9, 12, 13, and 16 have been amended to recite a first portion of a titanium or titanium nitride film which is arranged over an underlying CoSi film is removed by a first removal step using an ammonia-hydrogen peroxide-water mixture such that a second portion of the titanium or titanium nitride film remains covering the CoSi film. The second portion of the titanium or titanium nitride film on the CoSi film is removed by a second removal step using a hydrogen peroxide-water mixture to expose the CoSi film. Thus, when the first portion of the titanium or titanium nitride film is removed, the CoSi film covered with the titanium or titanium nitride film is not exposed.

In comparison, Jang discloses a method in which a layer underlying a titanium nitride film is exposed when a first portion of the titanium nitride film is removed. For example, in Jang, a layer of copper 190 is deposited over a substrate. A second etch stop layer 200, which may be titanium nitride, is formed to cover the copper layer 190, col. 6, lines 35-50. A first portion of the second etch stop 200 is removed from regions 220 to expose the underlying copper metal 190, col. 6, lines 53-57 and Fig. 3b. Thus, underlying copper layer 190 is exposed when the first portion of the titanium nitride film is removed, which is opposite the method recited in the amended claims. Furthermore, there is no mention in Jang of the titanium nitride film being formed over a cobalt film as is required by the amended claims.

In view of the above discussion, it is clear that the cited references, taken alone or in any combination do not fairly teach or suggest the claimed invention, for example, the CoSi film remaining covered by the titanium or titanium nitride film when the first

portion of the titanium or titanium nitride film is removed. Therefore, the withdrawal of this rejection is respectfully requested.

Claims 9-16 have been rejected under 35 U.S.C. § 112 ¶1 as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claims 9-16 relate to the two step removal of the titanium or titanium nitride film in which a first portion of the film is removed followed by a step in which a second portion of the film is removed. The Examiner is respectfully directed to pg. 20, lines 5-10 and 23-27 of the Applicant's disclosure. which support the claim recitations. Lines 5-10 on pg. 20 describe the removal of the titanium nitride film using an ammonia-hydrogen peroxide-water mixture "only for a time with which the CoSi layer will not be exposed." Lines 23-27 on pg. 20 state "the remaining titanium nitride film 62 in Figure 2 (D) is removed using a hydrogen peroxide-water mixture." Accordingly, the steps recited in claims 9-16 are clearly described in the Applicant's disclosure. There is no requirement that the words in the claim appear verbatim in the disclosure. Therefore, the withdrawal of the rejection of claims 9-16 is respectfully requested.

If the Examiner is of the opinion that the prosecution of this application would be advanced by a personal interview, the Examiner is invited to telephone undersigned counsel to arrange for such an interview.

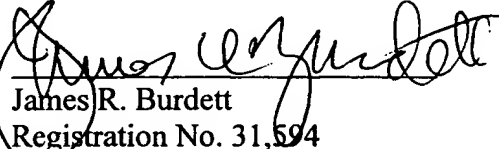
Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

The Commissioner is authorized to charge any fee necessitated by this Amendment to our Deposit Account No. 22-0261.

Respectfully submitted,

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Date

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VERSION SHOWING CHANGES MADE

IN THE CLAIMS:

Please amend the claims as follows:

9. (Twice Amended) A method of producing semiconductor devices by cobalt salicide technology with titanium nitride film as the cap film, comprising:

removing a first portion of said titanium nitride film which is arranged over underlying CoSi film by a first removal step using an ammonia-hydrogen peroxide-water mixture such that a second portion of said titanium nitride film remains; ~~and~~ covering said CoSi film; and

removing said second portion of said titanium nitride film on said CoSi film by a second removal step using a hydrogen peroxide-water mixture.

12. (Twice Amended) A method of producing semiconductor devices, comprising:

forming cobalt film on the top surface of a silicon substrate, which has a gate electrode and a diffusion film;

forming titanium nitride film as the cap film on the top surface of said cobalt film; selectively reacting the silicon of said silicon substrate and the cobalt of said cobalt film;

removing a first portion of said titanium nitride film which is arranged over underlying CoSi film by a first removal step using an ammonia-hydrogen-peroxide-water

mixture such that a second portion of said titanium nitride film remains; ~~and~~ covering said CoSi film; and

removing said second portion of said titanium nitride film remaining on said CoSi film by a second removal step using a hydrogen peroxide-water mixture.

13. (Twice Amended) A method of producing semiconductor devices by cobalt salicide technology with titanium film as the cap film, comprising:

removing a first portion of said titanium film which is arranged over underlying CoSi film by a first removal step using an ammonia-hydrogen peroxide-water mixture such that a second portion of said titanium nitride film remains; ~~and~~ covering said CoSi film; and

removing said second portion of said titanium film remaining on said CoSi film by a second removal step using a hydrogen peroxide-water mixture.

16. (Twice Amended) A method of producing semiconductor devices, comprising:

forming cobalt film on the top surface of a silicon substrate, which has a gate electrode and a diffusion layer;

forming titanium film as the cap film on the top surface of said cobalt film;

selectively reacting the silicon of said silicon substrate and the cobalt of said cobalt film;

removing a first portion of said titanium film which is arranged over underlying CoSi film by a first removal step using an ammonia-hydrogen peroxide-water-mixture such that a second portion of said titanium film remains; ~~and~~ covering said CoSi film, and

removing said second portion of said titanium film remaining on said CoSi film by a second removal step using a hydrogen peroxide-water mixture.